REMR TECHNICAL NOTE CS-MR-9.4

SPECIALIZED REPAIR TECHNIQUE: PREPLACED-AGGREGATE CONCRETE

PURPOSE: To provide information on preplaced-aggregate concrete for repair of concrete structures.

APPLICATION: Preplaced-aggregate concrete has been used for the resurfacing of lock walls (Ref a) and dams and for the repair of tunnel linings, piers, and spillways (Ref b). It may be used advantageously on large concrete repair jobs

- Where placement by conventional methods is difficult (e.g., massive reinforcing steel and embedded items are present or access to the area is difficult, such as the underpinning of the toe of a dam or apron).

- When low-volume change of the repair concrete is required to avoid cracking caused by excessive tensile stresses in the overlay concrete because of drying shrinkage and restraint provided by the existing concrete.

- Where underwater placement is necessary because dewatering is difficult, expensive, or impractical and water conditions permit.

DESCRIPTION: Preplaced-aggregate concrete gets its name from the method used for placement. Formwork is constructed and the coarse aggregate fraction (3/4- to 1-1/2-in. minimum) (Ref c) is densely placed inside the formwork. The coarse aggregate is washed and screened just prior to placement to remove all fines. Grout is then injected through the forms to provide the matrix. Grouting is begun at the bottom of the preplaced aggregate.

The grout typically consists of sand, cement, pozzolan, fluidifier, and an air-entraining admixture. The characteristics of the grout are affected by water content, sand grading, cement, pozzolan, and the types and amounts of admixtures. For each mixture there are optimum amounts of fillers and admixtures which produce the best pumpability or consistency. Proper proportioning of the structural grout mix components is necessary to produce the required strength and durability requirements of the finished preplaced-aggregate concrete. Mixture design tests are necessary for each job. Guidance on grout materials, coarse aggregate, and construction procedures for preplaced-aggregate concrete can be found in EM 1110-2-2000.

ADVANTAGES: Under ordinary drying conditions and proper curing, the drying shrinkage of preplaced-aggregate concrete is approximately one-half that of ordinary concrete (Ref d). This lower drying shrinkage is attributed to the high content of coarse aggregate and the grain-to-grain contact provided by preplaced-aggregate concrete. Less drying shrinkage can result in reduced cracking in concrete repair overlays.

When placement conditions are difficult because of repair locations or heavy reinforcement requirements, preplaced-aggregate concrete may be used to advantage and may result in fewer construction problems.

Preplaced-aggregate concrete has exhibited excellent bonding to properly prepared concrete surfaces and with the proper amount of entrained air has superior resistance to alternate cycles of freezing and thawing.

It is adaptable to underwater construction, and the use of formwork guarantees a flat, even surface not possible with tremie or underwater pumped operations.

DISADVANTAGES/LIMITATIONS: Proper proportioning of the structural grout mixture components is necessary to produce the required strength and durability requirements of the finished preplaced-aggregate concrete. Mixture design tests should be conducted for each job.

The formwork must be stronger and tighter than is normally suitable for conventional concrete. Stronger, tighter formwork minimizes grout leakage and resists the lateral pressure that occurs as the grout is injected under pressure.

Recent bid prices indicate that the cost of preplaced-aggregate concrete may be significantly higher than that of conventional concrete for normal concrete repair jobs. The increased cost is generally attributed to the stronger and tighter formwork required and the limited number of contractors with experience in the use of preplaced-aggregate concrete. Therefore, if preplaced-aggregate concrete is the desired repair material for jobs other than those for which it is particularly adaptable (i.e., difficult placement conditions), it must be specified uniquely and not as an alternate.

The quality of preplaced-aggregate concrete underwater repairs can be influenced by highly contaminated water. Where underwater repairs are planned and the water is known or suspected to be contaminated, testing should be conducted to determine the influence the contamination will have on the quality of the concrete and whether this influence can be tolerated, eliminated, or controlled.

PERSONNEL REQUIREMENTS: Since preplaced-aggregate concrete is most adaptable to special types of repairs, personnel should be well qualified for the particular type of repair and experienced in the use of preplaced-aggregate concrete. For underwater applications, qualified diving teams are required and experienced supervision is necessary topside to assure proper aggregate placement, structural grout mixture proportioning, and mixing and pumping of grout into the aggregate mass.

METHODS OF INSPECTION: Standard methods of inspection of conventional concrete can be applied to preplaced-aggregate concrete. In addition, calculating the void ratio of the coarse aggregate and checking against the actual volume of grout pumped into the stone will serve as a check for concrete quality. Sophisticated techniques such as sonar and high-resolution acoustic mapping are available, but at a cost.

REFERENCES:

a. McDonald, J. E. 1987 (Dec). "Rehabilitation of Navigation Lock Walls: Case Histories," Technical Report REMR-CS-13, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

b. McDonald, J. E. 1980 (Apr). "Maintenance and Preservation of Civil Works Structures; Report 2, Repair of Erosion Damaged Structures," Technical Report C-78-4, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

c. Headquarters, Department of the Army. 1983 (Jul). "Preplaced-Aggregate Concrete," Civil Works Construction Guide Specifications, CW-03362, Washington, DC.

d. US Bureau of Reclamation. 1981. Concrete Manual, 8th Edition, Chapter VIII, Denver, CO.

e. Headquarters, Department of the Army. 1985. "Standard Practice for Concrete," EM 1110-2-2000, Washington, DC.